Physicomimetics:
Physics-Based Swarm Intelligence

Chapter 1
Physicomimetic Motion Control of Physically Constrained Agents

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1.1 Introduction

Artificial physics provides an intuitive, simple, and robust scheme for controlling a group of robots without having to explicitly specify a trajectory for each agent. This is accomplished by specifying behavior rules in the form of artificial force fields that define the interactions among agents. In most instances, the direction of the force is defined along a vector between each pair of agents and its magnitude by the distance between them. A typical formulation is based on an inverse square law with an attract–repel (AR) boundary, across which the direction of the force changes.

The trajectory of each agent is determined by the sum of the artificial forces acting on its virtual mass. Forces are determined based only on the position of the agent relative to other points in the environment. These may be other robots, observed obstacles, user-specified objectives, or other points computed to improve the swarm's ability to accomplish its mission. This inherent flexibility and scalability allows heterogeneous swarms to accomplish complex missions without computing complete robot trajectories in advance.

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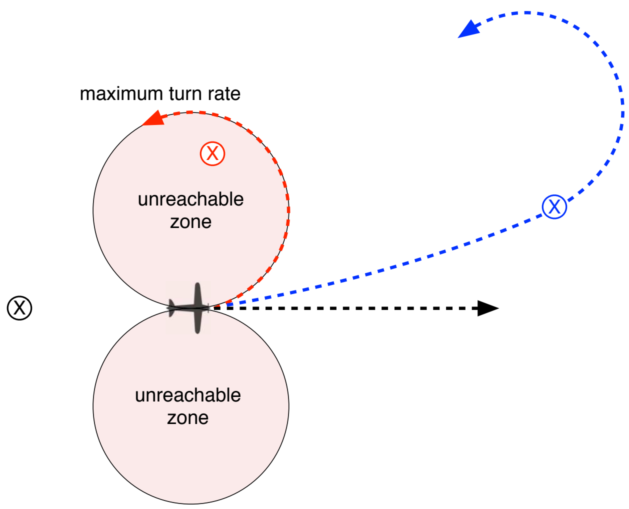

Fig. 1.1: Possible flight paths of a single UAV attracted to a single attractor particle in various positions indicated by $\otimes$